www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 3258-3262

www.thepharmajournal.com
Received: 14-10-2022
Accepted: 17-11-2022

PA Sasane
M.Sc. (Horti.) Scholar, Department of Horticulture, College of Agriculture, Parbhani. VNMKV, Parbhani. Maharashtra, India

AS Lohakare
Assistant Professor, College of Horticulture, Parbhani, VNMKV, Parbhani. Maharashtra, India

SR Barkule
Assistant Professor, College of Agriculture, Parbhani, VNMKV, Parbhani. Maharashtra, India

Corresponding Author:
PA Sasane
M.Sc. (Horti.) Scholar, Department of Horticulture, College of Agriculture, Parbhani. VNMKV, Parbhani. Maharashtra, India

Effect of chemicals and biomix application on growth and success of jamun grafts cv. Konkan Bahadoli

PA Sasane, AS Lohakare and SR Barkule

Abstract
An investigation entitled "Effect of chemicals on success and survival of softwood grafts in jamun (*Syzigium cumini* L. Skeels) cv. Konkan Bahadoli" was carried out during the year 2021- 2022. The experiment was laid out in randomized block design with eleven treatments replicated trice. The result revealed that among the different treatments, treatment (T2) GA3 125 ppm + Biomix 1% showed better in terms of minimum number of days required for sprouting (21.47 days) at 30 DAG. Highest success percentage (93.30%) was recorded in treatment (T2) GA3 125 ppm + Biomix 1%, (T1) GA3 100 ppm + Biomix 1% and (T8) TRIA 750 ppm + Biomix 1% at 30 DAG. Graft growth attributes *viz*., maximum height of grafts (62.98 cm), maximum girth of scion (6.22 mm), maximum sprout length (20.52 cm), maximum number of shoots (2.60) and maximum fresh and dry weight of shoot (30.53 g and 16.11 g) were observed with the treatment (T2) GA3 125 ppm + Biomix 1% at 150 DAG. The maximum number of leaves (21.78), maximum fresh weight and dry weight of leaves (19.02 g and 6.28 g) at 150 DAG were observed in treatment (T8) TRIA 750 ppm + Biomix 1% and maximum leaf area (39.42 cm2) at 150 DAG was recorded in treatment (T10) KNO3 1% + Biomix 1%.

Keywords: Biomix, chemicals, growth, jamun, Konkan Bahadoli, graft success

Introduction
Jamun (*Syzygium cuminii* L. Skeels) is an important but under-exploited indigenous fruit tree of India. It is a beautifully shaped tree which is grown for its delicious fruits, shade and windbreak on the bunds of roadside avenues. It has a hardy nature and multifarious uses and have great potential for commercial and economic development in wastelands and dry-land horticulture. Jamun belongs to the genus *Syzygium* and family Myrtaceae having chromosome number 2n=40. There are about 400 to 500 species of which a few are considered edible fruit bearers (Chundawat, 1990) [2]. The jamun is a cross-pollinated crop and pollination happens mostly due to honey bees, houseflies and wind. Jamun is also known as jambul, black plum, java plum, etc. It is an indigenous fruit crop and also found in Thailand, Philippines, Madagascar and some other countries. India ranks second next to Brazil in area and production in the world (Bodkhe and Rajput 2010) [1].

Plant propagation is an integral part of jamun's improvement since jamun has a long gestation period, therefore it requires more care in the selection of genuine planting material at the time of establishment of orchard. Softwood grafting is recommended in jamun as plants propagated by softwood grafting have a short bearing period of 4-5 years and multiplication on large scale is possible in a short period and true-to-type plants are obtained. Softwood grafting is recommended in jamun and has significant advantages over other propagation methods but it has other drawbacks as well. In softwood grafting, the growth of grafts is very slow also the growth is not healthy and vigorous. In Jamun softwood grafting, it is observed that there is good sprouting at the initial stage but in the later stages, it shows difficulties in development. Hence expected growth rate cannot achieved in softwood grafting.

Nowadays plant growth regulators are widely used to increase graft success and growth. Growth regulators like GA3 and NAA are employed for rooting, vegetative propagation, and overall yield of several plants (Mishra and Mishra, 2003) [11]. There is great scope for the use of chemicals and Biomix for increasing success and growth of softwood grafts in jamun. However, there is very less research work carried out on this aspect in jamun grafts.

With this view, the present experiment was undertaken entitled "Effect of chemicals on success and survival of softwood grafts in jamun (*Syzigium cumini* L. Skeels) cv. Konkan Bahadoli." to increase the growth and success and of jamun grafts.

Material and Methods

The present experiment entitled 'Effect of chemicals on success and survival of softwood grafts in jamun (*Syzigium cumini* L. Skeels) cv. Konkan Bahadoli,' was conducted at Central Nursery, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) during the year 2021-22. The experiment was laid out in randomized block design with eleven treatment replicated trice. The experiment consisted of 11 treatments *viz*., (T1) GA3 100 ppm + Biomix 1%, (T2) GA3 125 ppm + Biomix 1%, (T3) NAA 100 ppm + Biomix 1%, (T4) NAA 125 ppm + Biomix 1%, (T5) Urea 0.5% + Biomix 1%, (T6) Urea 1% + Biomix 1%, (T7) TRIA 500 ppm + Biomix 1%, (T8) TRIA 750 ppm + Biomix 1%, (T9) KNO3 0.5% + Biomix 1%, (T10) KNO3 1% + Biomix 1% and (T11) Control.

Scion sticks were collected in morning hours and were kept in wet gunny bags to conserve moisture. The scion sticks were selected suitable to the thickness of rootstocks. The activated scion sticks with matching slant cuts of 2"-2.5" length on either side were placed into the cut to form a wedge. The cut end of the scion is shaped to a wedge of 4-5 cm long by chopping the bark

and wood from two opposite sides. The rootstock seedling was cut to a length of approximately 9 inches in polybags from soil surface, and a wedge was made to a depth of about 2.5 inches. A cut of a similar length was made on the rootstock to perfectly match the respective cambiums and the activated scion stick with matching slant cuts of 2"-2.5" length on either side was placed into the cut to form a wedge. The wedge was then tightly attached with a 100-gauge polythene tape. Then, to protect them from heavy rain or other weather conditions, the grafts were stored in shade

net house. Chemicals *viz*., GA3, NAA, Urea, TRIA, KNO3 and Biomix were given through foliar spray.

Result and Discussion

The perusal of the data presented in Table 1 and Table 2 regarding growth and success of jamun grafts as influenced by foliar spray of chemicals recorded significant differences.

Days required for sprouting

Among the different treatments, treatment (T2) GA3 125 ppm + Biomix 1% showed better in terms of minimum number of days required for sprouting (21.47days) and maximum number of days required for sprouting (29.24 days) was observed in treatment (T11) control at 30 DAG this might due to the Gibberellic acid which affect growth by cell growth and cell elongation, which bought early emergence of sprout, early and more callus formation might result in early sprouting. Present results are in accordance with the results obtained by Pawar *et al*. (2018) [12] in custard apple. This also might due to Biomix which contains many root colonizing bacteria including the nitrogen fixing *Azospirillum* and phosphorus solubilizing *Pseudomonas spp*. which are known to produce growth hormones such as auxins. Thus, increased level of auxins (PGR's) resulted in earlier completion of physiological processes involved in rooting and sprouting of grafted plants.

Success percentage

The maximum success percent of grafts (93.30%) was recorded in treatment (T1) GA3 100 ppm + Biomix 1%, (T2) GA3 125 ppm + Biomix 1%, and (T8) TRIA 750 ppm + Biomix 1% (93.30%). While minimum success percent (66.66%) of grafts was recorded in treatment (T11) control. It might be due to the effect of GA3 participating in the activity of alpha amylase, which catalyzes the starch conversion into simple carbohydrates, as a result chemical energy is liberated which is used in the activation of sprouts in grafts and it is due to the favorable internal and external conditions like optimum humidity and moderate temperature and biochemical status. These results are conformity with the Pawar *et al*. (2018) [12] in custard apple. Triacontanol is an effective growth regulator that can significantly improve plant growth (Perveen *et al*., 2014) [13]. This growing regulatory substances are effective on the biosynthesis of secondary metabolites and role plays to set up the process associated with the physiology and biochemistry of plants and in turn resulted in better success of grafts (Jaybhay *et al*., 2010) [6]. Significant results are also might due to microorganism inoculants which present in the biomix which carried out biological nitrogen fixation, solubilization of insoluble phosphates and mobilization of plant nutrients in more quantities are made available for plants by the root associated organisms. Increased nitrogen, phosphorous and potassium content of inoculated plants at different stages of plant growth results in better development of plants have been found resulting in significant increase in growth of plants (Salisburry and Ross, 1985) [17].

Height of graft (cm)

Treatment (T2) showed significant effect on height of graft, maximum height of graft (62.98 cm) was recorded in treatment (T2) GA3 125 ppm + Biomix 1% and minimum height of graft (37.37 cm) was recorded in treatment (T11) control at 150 DAG. This might due to GA3 as this hormone increased osmotic uptake of nutrients, causing cell multiplication and cell elongation in the cambium tissue of the internodal region and thus increased height of the grafts. Similar results were obtained by Malshe *et al*. (2016) [9] in khirni rootstock and Pawar *et al*. (2018) [12] in custard apple. The improvement in growth may also be due to the use of biofertilizers that outcomes in

expanded length of shoots, gracefully of all supplements so at last builds the vegetative growth of the plants. These perceptions are in conformity with those of Khan *et al*. (2009) [8] in citrus.

Girth of scion (mm)

The maximum girth of scion (6.22 mm) was found in treatment (T2) GA3 125 ppm + Biomix 1% and minimum girth of scion (4.52 mm) was recorded in treatment (T11) control at 150 DAG, the increase in girth of scion might have resulted because of increased photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products resulting in cell elongation and rapid cell division in the growing portion (Sargent, 1965) [18]. The elongation of internodes induced by the cell elongation, increase in cell size and rapid cell division which resulted in increased girth of scion. It might also be due to the application of biomix as it is a mixture of nitrogen fixer bacteria, phosphorous solubilizing bacteria and potassium solubilizing bacteria which helps for increasing growth of the shoots and better assimilation of nutrients in plants. Similar results were obtained by Vasantha *et al*. (2014) [22] in tamarind and Hota *et al*. (2018) [4] in jamun.

Sprout length (cm)

Maximum sprout length (20.52 cm) was recorded in treatment (T2) GA3125 ppm + Biomix 1% and minimum sprout length (6.40 cm) was recorded in treatment (T11) control at 150 DAG. Sachs *et al*., (1960) [16] reported that the rapid growth of sprouts was a result of formation of large number of cells and the elongation of the individual cell by the application of GA3. The present results are in harmony with the previous findings of Bhujbal *et al*., (2012) in sapota, the improvement in growth may be because of the use of biofertilizers that outcomes in expanded length of shoots, gracefully of all supplements so at last builds the vegetative growth of the plants. These perceptions are in conformity with those of Khalid *et al*. (2013) [7] in strawberry.

Number of shoots

Maximum number of shoots (2.60) was observed in treatment (T2) GA3 125 ppm + Biomix 1% and minimum number of shoots (1.67) was recorded in treatment (T11) control at 150 DAG. It might be due to fact that gibberellin (given in the form of GA3 sprayed) is a constituent of protein which is essential for formation of protoplasm and thus, affecting cell division and cell elongation. All these contributed in enhancing shoot length and number of shoots. The present findings are in conformation with the report of Singh and Sheo (2000) [19] in khasi mandarin and *C. valkameriana*. Significant results are also might due to microorganism inoculants which present in the biomix carried out biological nitrogen fixation, solubilization of insoluble phosphates and mobilization of plant nutrients in more quantities are made available for plants by the root associated organisms.

Fresh weight of shoot (g)

Maximum fresh weight of shoot (30.53 g) were observed with the treatment (T2) GA3 125 ppm + Biomix 1% and minimum fresh weight of shoot (15.81 g) was recorded in treatment (T11) control at 150 DAG. This might also due to the contribution of GA3 which increases fresh weight of shoots by mobilizing the water and nutrient transport at higher rate during the period of cell elongation which might have promoted more production of photosynthetic product (food) translocated them to various plant parts which might have resulted in better fresh weight of shoot these results are confirmation with Pawar *et al*., (2018) [12] in custard apple. Gluconoacterobacter an organism present in biomix has nitrogen fixing ability and also known to synthesis indole-3-acetic acid which promote the growth of the associated plant species and in turn increase the biomass of shoot (Jambotkar *et al*., 2008) [5].

Dry weight of shoot (g)

The maximum dry weight of shoot (16.11 g) was found in treatment (T2) GA3 125 ppm + Biomix 1% while the minimum dry weight of the shoot (7.95 g) was recorded in treatment (T11) control at 150 DAG. The application of GA3 resulted in expanding internodes and apical region of young leaves. The increase in length was accompanied by increased dry weight and during expansion there was direct relation between dry weight and volume of water on the internode. The crude cell wall fraction of the dry weight also increases greatly and there was a direct relation between internode volume and amount of wall. Similar results were observed by Lalitha *et al*. (2020) in aonla. Increase in fresh and dry weight of the aerial part by application biomix is due to the enhanced nitrogen-fixing, better absorption of nutrients especially N, secretion of growth promoting substances. The results obtained are in accordance with the results obtained by Umar *et al*. (2009) [21].

Number of leaves

The maximum number of leaves (21.78) was recorded in treatment (T8) TRIA 750 ppm + Biomix 1% and minimum number of leaves (10.33) was observed in treatment (T11) control at 150 DAG. According to Hinerman and Kunkel (1982) [3] triacontanol directly activates the genes that control the process of photosynthesis. These genes in turn activate enzymes that control the chemical process of photosynthesis. Therefore, it is likely that triacontanol given in the optimum concentration can more effectively increase the activity of enzymes to control the process of photosynthesis that occurs in the cells of the leaves. The present results are in accordance with the previous findings of Tiwari *et al*., (2017) [20] in strawberry. The increased in number of leaves may be due to positive benefits of bio-fertilizers (Biomix) which increase the N uptake with increased nitrate reductase activity in the plant which is in conformity with the findings of Wani (1990) [23].

Fresh and dry weight of leaves (g)

Maximum fresh and dry weight of leaves (19.02 g and 6.28 g) was observed in treatment (T8) TRIA 750 ppm + Biomix 1% and minimum fresh and dry weight of leaves (6.54 g and 0.84 g) was recorded in treatment (T11) control at 150 DAG. TRIA enhances the rate of photosynthesis, protein biosynthesis, the transport of nutrients in plants and enzyme activity, reducing complex
carbohydrates among many other purposes resulting in maximum number of leaves and thus maximum fresh weight of leaves. The increase in fresh and dry weight of leaves might be due to the application of biomix as it is mixture of nitrogen fixer bacteria, phosphorous solubilizing bacteria and potassium solubilizing bacteria which helps for increasing growth of the leaves and in turns resulted in increased biomass of leaves.

Leaf area (cm2)

The leaf area was significantly influenced by the treatment (T10) as maximum leaf area (39.42 cm2) was recorded in treatment (T10) KNO3 1% + Biomix 1% while minimum leaf area (26.34 cm2) was recorded in treatment (T11) control at 150 DAG. This may be due to stimulatory action of KNO3 to promote leaf growth through the presence of NO3 (Ratan and Reddy (2004) [15] in custard apple). Presence of potassium play important roles affecting many physiological processes
related to stomatal behaviour, osmoregulation, enzyme activity and cell expansion, this might be the outcome of the propensity of KNO3 to enlarge the leaf area. The results are in accordance with Pawar *et al*. (2018) [12] in custard apple. The increase in leaf area might be also due to the application of biomix as it a mixture of nitrogen fixing bacteria, phosphorous solubilizing bacteria and potassium solubilizing bacteria which helps for increasing growth of the leaves. Similar, results were reported by Mandal *et al*. (2021) [10].

Table 1: Effect of chemicals on days required for sprouting, Success percentage, height of grafts, girth of scion, sprout length and number of shoots at 150 DAG.

Treatment No.	Treatments	Days required for sprouting	Success percentage (%)	Height of graft (cm) at 150 DAG	Girth of scion (mm) at 150 DAG	Sprout length (cm) at 150 DAG	Number of shoots at 150 DAG
T1	GA3 100 ppm + Biomix 1%	22.67	93.30	59.60	5.99	16.63	2.30
T2	GA3 125 ppm + Biomix 1%	21.47	93.30	62.98	6.22	20.52	2.60
T3	NAA 100 ppm + Biomix 1%	25.88	80.00	51.68	5.04	14.10	2.13
T4	NAA 125 ppm + Biomix 1%	23.60	80.00	47.00	4.99	13.70	2.13
T5	Urea 0.5% + Biomix 1%	25.56	73.30	43.29	5.05	11.18	2.07
T6	Urea 1% + Biomix 1%	26.88	80.00	41.84	5.27	10.70	2.10
T7	TRIA 500 ppm + Biomix 1%	27.24	86.60	50.36	5.57	12.45	2.17
T8	TRIA 750 ppm + Biomix 1%	26.66	93.30	55.97	5.94	12.97	2.20
T9	KNO3 0.5% + Biomix 1%	28.85	80.00	40.85	5.22	9.04	2.00
T10	KNO3 1% + Biomix 1%	24.49	80.00	49.40	4.81	10.70	1.93
T11	Control	29.24	66.66	37.37	4.52	6.40	1.67
SE (m) ±		0.58	0.26	1.53	0.08	0.67	0.08
CD@5%		1.63	0.72	4.31	0.24	1.90	0.24

Table 2: Effect of chemicals on fresh and dry weight of shoot, number of leaves and fresh and dry weight of leaves and leaf area at 150 DAG.

Treatment No.	Treatments	Fresh weight of shoot (g) at 150 DAG	Dry weight of shoot (g) at 150 DAG	Number of leaves at 150 DAG	Fresh weight of leaves(g) at 150 DAG	Dry weight of leaves (g) at 150 DAG	Leaf area (cm2) at 150 DAG
T1	GA3 100 ppm + Biomix 1%	27.09	14.78	17.21	16.60	4.35	34.51
T2	GA3 125 ppm + Biomix 1%	30.53	16.11	18.30	18.64	5.41	35.71
T3	NAA 100 ppm + Biomix 1%	19.84	10.67	16.43	15.51	3.65	33.44
T4	NAA 125 ppm + Biomix 1%	19.76	10.25	15.81	14.79	3.17	32.03
T5	Urea 0.5% + Biomix 1%	21.84	14.08	11.47	9.74	2.03	32.03
T6	Urea 1% + Biomix 1%	18.85	9.42	15.23	13.63	2.66	30.94
T7	TRIA 500 ppm + Biomix 1%	23.51	14.37	16.73	16.55	4.23	28.62
T8	TRIA 750 ppm + Biomix 1%	28.77	15.18	21.78	19.02	6.28	34.20
T9	KNO3 0.5% + Biomix 1%	20.81	13.15	12.40	10.34	2.13	36.42
T10	KNO3 1% + Biomix 1%	18.69	8.58	13.17	11.45	2.18	39.42
T11	Control	15.81	7.95	10.33	6.54	0.84	26.34
SE (m) ±		1.06	0.75	0.72	0.81	0.12	0.47
CD@5%		2.97	2.11	2.02	2.28	0.34	1.32

Conclusion

Among the different treatment combination (T2) (GA3 125 ppm + Biomix 1%) was found better for most of the growth parameter *viz*., minimum number of days required for sprouting, height of grafts, girth of scion (mm), sprout length (cm), number of shoots and fresh and dry weight of shoot (g) except number of leaves and fresh and dry weight of leaves (g) which was observed maximum under treatment combination (T8) (TRIA 750 ppm + Biomix 1%) and leaf area (cm2) which was recorded maximum under treatment (T10) (KNO3 1% + Biomix 1%). Maximum success percentage was observed in treatment (T1) GA3 100 ppm + Biomix 1%, (T2) (GA3 125 ppm + Biomix 1%) and (T8) (TRIA 750 ppm + Biomix 1%).

References

1. Bodkhe VA, Rajput L. Propagation studies in jamun. International Journal of Agriculture Sciences. 2010;6:250-52.
2. Chundawat BS. Arid Fruit Culture, Pub. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi; c1990. p. 165-171.
3. Hinerman DI, Kunkel SL. Triacontanol as a growth stimulant - A report of two experiments. Journal American Rhododendron Society, 1982, 36(3).
4. Hota SN, Karna AK, Jain PK, Dakhad B. Effect of gibberellic acid on germination, growth and survival of jamun (*Syzygium cumini* L. Skeels). The Pharma Innovation Journal. 2018;7(8):323-326.
5. Jambotkar RK, Lakshman UC. Effect of AM fungus inoculation with additional phosphorus on the growth of *Brassica juncea* Linn. saplings. International Journal of Plant Sciences. 2009;4(1):52-54.
6. Jaybhay S, Chate P, Ade A. Isolation and identification of crude triacontanol from rice bran wax. Journal of Experimental sciences. 2010;1(2):26.
7. Khalid S, Qureshi KM, Hafiz IA, Khan KS, Qureshi US. Effect of organic amendments on vegetative growth, fruit and yield quality of strawberry. Pakistan Journal of Agricultural Research. 2013;26(2):104-112
8. Khan MA, Begum H, Lakshmi GS. Effect of INM on growth and chlorophyll content of acid lime in calcareous soils of Andhra Pradesh. Indian Journal of Horticulture. 2009;66(3):385-389.
9. Malshe KV, Desai BG, Palshetkar MG. Effect of different growth regulators on growth of khirni (*Manilkara hexandra* L.) rootstock. Annals of Plant Physiology. 2016;30(2):15-17.
10. Mandal K, Bahadur V, Ekka AB. Effect of different organic media on growth and establishment of strawberry (*Fragaria ananassa*) cv. Winter Dawn under east-singhbhum (Jharkhand) agro-climatic conditions. The Pharma Innovation Journal. 2021;10(9):1603-1608.
11. Misra KK, Mishra DS. Role of plant growth substances in forest nursery stock production. In: Forest Tree Seeds

and Nursery Management: Current Trends (Eds.) Singh, V. and Lavania, S.K. Bishen SMPS Publ & Dis of Scientific Books, Dehra Dun; c2003. p. 193-209.
12. Pawar TA, Patil SG, Deshpande DP. Studies on effect of chemicals on growth of rootstock for softwood grafting in custard apple (*Annona squamosa* L.). M.Sc. (Hort.). Thesis submitted to Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani; c2018.
13. Perveen S, Shahbaz M, Ashraf M. Triacontanol-induced changes in growth, yield, leaf water relations, oxidative defense system, minerals, and some key osmoprotectants in Triticum aestivum under saline conditions. Turkish Journal of Botany. 2014;38(5):896-913.
14. Ramteke V, Paithankar DH, Ningot EP, Kurrey V. Effect of GA3 and propagation media on seed germination and vigour of papaya cv. Coorg Honey Dew. The Bioscan. 2015;10(3):1011-1016.
15. Rattan BP, Reddy YN. Influence of gibberellic acid on custard apple (*Annona squamosa* L.) seed germination and subsequent seedling growth. Journal of Research ANGRAU. 2004;32(2):93-95.
16. Sachs RM, Lang J, Bretz CF, Roach J. Shoot histogenesis: Sub-apical meristematic activity in a caulescent plant action of gibberellic acid and AMO 1618. American Journal of Botany. 1960;47:260-266.
17. Salisbury FB, Ross CW. Plant Physiology, (3thed.). Belmont: Wadsworth publishing co; c1985.
18. Sargent JA. The penetration of growth regulators into leaves. Annual Review of Plant Physiology. 1965;16(1):1-12.
19. Singh IP, Sheo G. Effect of urea, GA3 and ZnSO4 spray on the growth of citrus seedlings in two species. Annals of Plant Physiology. 2000;14(1):39-42.
20. Tiwari AK, Saravanan S, Lall L. Influence of different plant growth regulators on vegetative growth and physico-chemical properties of strawberry (*Fragaria x ananassa* Duch.) cv. Chandler. Plant Archives. 2017;17(1):367-370.
21. Umar I, Wali VK, Kher R, Jamwal M. Effect of FYM, urea and *Azotobacter* on growth, yield and quality of strawberry cv. Chandler. Notulae Botanicae Horti Agrobotanici Cluj-Napoca. 2009;37(1):139-143.
22. Vasantha PT, Vijendrakumar RC, Guruprasad TR, Hanumanthaiah MR, Muttappanavr RD. Studies on influence of growth regulators and nutrient foliar spray on seedling growth of tamarind (*Tamarindus indica* L.). The Asian Journal of Horticulture. 2014;9(1):206-209.
23. Wani SP. Inoculation with associative nitrogen-fixing bacteria: Role in cereal grain production improvement. Indian Journal of Microbiology. 1990;30(4):363-393.